Device Class Power Management Reference Specification

Display Device Class

Draft proposal
v0.9

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Revision History

Revision	Date	Comments
0.0	3/25/96	Initial proposal for consideration
0.9	10/11/96	Added state transition latencies

Scope

This specification defines the behavior of Display devices as it relates to power management, and, specifically, to the four device power states defined for the OnNow Architecture. The specification specifically applies to CRT monitors, LCD Panels and video controllers for them. It is intended that Display vendors and system makers will be able to design consistent power-manageable products, and that OS vendors will be able to implement an appropriate display power management policy based on the contents of this specification.

General Device Power Management Considerations

In the OnNow architecture, power management of individual devices is the responsibility of a policy owner in the Operating System, generally a class-specific driver. This policy-owner will implement a power conservation policy that is appropriate for devices in its class. The policy will operate in conjunction with a global system power policy implemented in the operating system (i.e. is the system Working or Sleeping?). In general, the device-class power conservation policy strives to reduce power consumption while the system is Working by transitioning amongst various available power states according to device usage. Since the policy-owner in the Operating System has very specific knowledge of when a device is in use, or potentially in use, there is no need for hardware timers or such to determine when to make these transitions. Similarly, this level of understanding of device usage makes it possible to use fewer device power states. Generally, intermediate states attempt to draw a compromise between latency and consumption due to the uncertainty of actual device usage. With the increased knowledge in the OS, crisp decisions can be made about whether the device is needed at all. With this ability to turn devices off more frequently, the benefit of having intermediate states diminishes.

The policy-owner also determines what class-specific events can cause the system to transition from Sleeping to Working, and enables this functionality based on application or user requests. Note that the definition of the wake-up events that each class supports will influence the system's global power policy in terms of the level of power conservation the Sleeping state can attain while still meeting wake-up latency requirements set by applications or the user.

In the OnNow architecture, bus drivers also implement power policy for their bus class (e.g. PCI, USB, etc..). In general, the Bus driver has responsibility for tracking the device power states of all devices on its bus, and transitioning the Bus itself to only those power states that are consistent with those of its devices. This means that the Bus state can be no lower than the highest state of one of it's devices. However, enabled wake-up events can affect this as well. For example if a particular device is in the D2 state and set to wake-up the system, and the bus can only forward wake-up requests while in the D1 state, then the Bus must remain in the D1 state even if all devices are in a lower state.

Device power state transitions are explicitly commanded by the driver and invoked through bus-specific mechanisms (e.g. ATA Standby command, USB Suspend, etc..). Note that the explicit command for entering the D3 state may be the removal of power. In some cases, bus-specific mechanisms are not available and device-specific mechanisms must be used.

The following definitions apply to devices of all classes:

- **D0**: Device is on and running. It is receiving full power from the system, and is delivering full functionality to the user.
- **D1**: Class-specific low-power state (defined below) in which device context may or may not be lost. Buses in D1 cannot do anything to the bus which would force devices on that bus to loose context.
- **D2**: Class-specific low-power state (defined below) in which device context may or may not be lost. Attains greater power savings than D1. Buses in D2 may cause devices on that bus to loose some context (e.g. the bus reduces power supplied to the bus). Devices in D2 must be prepared for the bus to be in D2 (or higher).
- **D3**: Device is off and not running. Device context is lost. Power may be removed from the device.

Any device context lost must be restored by the device driver when returning the device to the D0 state.

CRT Monitor and LCD Panel Power State Definitions

D0

This state is equivalent to the 'On' state defined in the VESA DPMS specification (see Related Documents) and is signaled to the display using the DPMS method.

- Display: Fully on
- Video Image: Active

D1

This state is equivalent to the 'Standby' state defined in the VESA DPMS and is signaled to the display using the DPMS method.

- Display: Functional but may be conserving energy
- Video Image: Blank

Latency to return to D0: Less than 5 seconds

D2

This state is equivalent to the 'Suspend' state defined in the VESA DPMS specification and is signaled to the display using the DPMS method.

- Display: Functional and conserving energy
- Video Image: Blank

Latency to return to D0: Less than 10 seconds

D3 (Power may be removed)

This state is equivalent to the 'Off' state defined in the VESA DPMS specification and is signaled to the display using the DPMS method.

- Display: Non-functional
- Video Image: Blank

Video Controller Power State Definitions

D0

- Back-end : On
- Display signals: According to VESA DPMS for 'On' state
- Video Controller Context: Preserved
- Video Memory Contents: Preserved

D1

- Back-end : Off
- Display signals: According to VESA DPMS for 'Standby' state
- Video Controller Context: Preserved
- Video Memory Contents: Preserved

Latency to return to D0: Less than 1 second

D2

- Back-end : Off
- Display signals: According to VESA DPMS for 'Suspend' state
- Video Controller Context: Lost
- Video Memory Contents: Lost

Latency to return to D0: Less than 5 seconds

D3 (Power may be removed)

- Back-end : Off
- VESA DPMS mode: Undefined
- Video Controller Context: Lost (Power removed)
- Video Memory Contents: Lost (Power Removed)

Display Device Power Conservation Policy

Present State	Next State	Cause
D0	D1	User inactivity for a period of time (T1)
D1	D2	User inactivity for a period of time (T2 >T1)
D2	D3	User inactivity for a period of time (T3 >T2)
D1, D2, D3	D0	• User activity • Application UI change (i.e. dialog pop-up) while application has NOT indicated that it does NOT need the Display device

NOTE: These state transitions apply to both the display and the video controller. However, the display transitions are a result of signaling from the video controller, not a result of explicit commands from the policy-owner.

Display Device Wake-up Events

Display devices which incorporate a system power switch will generate a wake-up event when the switch is pressed while the system is sleeping.

Minimum Display Device Power Capabilities

State	Compliance Requirement
D0	Mandatory
D1	Optional
D2	Mandatory
D3	Mandatory

Related Documents and References

Display Power Management Signaling Specification (DPMS)
Video Electronics Standards Association (VESA)
2150 North First Street
Suite 440
San Jose, CA 95131-2029